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**Impedance-matched electrical connector.**

An impedance-matched electrical connector comprising a plug connector member (30) and a matable jack connector member (35) for an electric connection between printed wiring boards. The plug connector member (30) comprises a plug housing (31) of insulating material in which planar and elongate male conductors (32), a first row of male signal terminals (33), and a second row of male signal terminals (33) are arranged in parallel planes. A conductive ground shell (34) is attached to the outer peripheral surface (31a) of the plug housing (31), so that the first and second rows of male signal terminals (33) are arranged between the elongate male conductors (32) and a planar portion of the ground shell, respectively, to thereby form a strip line structure by which an impedance of the connector is matched to an impedance of the printed wiring boards and the amount of crosstalk is relatively low.

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The present invention relates to an impedance-matched electrical connector comprising a plug connector member and a jack connector member matable with the plug connector member for an electric connection between impedance-matched printed wiring boards.

With the development of high speed signal processing in computers, it has been required that multielectrode connectors for computers should have a characteristic impedance matched with a characteristic impedance of printed wiring boards and cables to avoid a reflection of signals in the connectors, and that the connectors should provide for a low crosstalk between the signals. To meet such requirements for the high speed signal processing, it is necessary that the printed wiring boards, wirings of the cables, and terminals in the electrical connectors are not mere electric connections means, but are also transmission lines. Namely, it is desirable to arrange the signal lines relative to the ground conductor in a constant disposition (or a cross-sectional shape) in order not to disturb electromagnetic waves around the signal lines.

There are mainly two kinds of signal transmissions, (a) an unbalanced transmission that uses a signal conductor and a ground conductor, and (b) a balanced transmission that uses a positive signal conductor and a negative signal conductor. Unbalanced transmission is frequently used in the print circuit boards and electric casings for digital signal transmissions. The unbalanced transmission is classified into the following three types depending on the disposition of the signal conductor and the ground conductor, i.e., a coaxial structure in which a core signal conductor is surrounded by a cylindrical ground conductor with a dielectric material (insulating material) filled therebetween; a strip line structure in which a signal conductor is sandwiched between a pair of ground planes with a dielectric material filled therebetween, and a microstrip line structure in which a signal conductor is arranged parallel to only one ground plane with a dielectric material filled therebetween.

Transmission characteristics vary between the strip line structure and the microstrip line structure. In the strip line structure, the occurrence of noise and crosstalk are relatively low. signals are less affected by external electromagnetic fields, and impedance characteristic is stable. In the microstrip line structure, signals are relatively affected by external electromagnetic fields (shielding effect is small). the occurrence of noise is high, and impedance characteristics are unstable. Also, the signals are affected by the electromagnetic fields emitted from the signal conductors themselves depending on the disposition of the dielectric material and the conductors and the occurrence of crosstalk is relatively high.

Impedance varies between the strip line structure and the microstrip line structure when dimensional conditions of the corresponding elements are identical. It is well known that the impedance  $Z_0$  can be calculated by the following relationships, in which  $\epsilon$  is a dielectric constant of dielectric material;  $d$  is a diameter of a signal conductor when it has a circular cross section;  $h$  is a distance between the center of the signal conductor and the ground plane.

The impedance  $Z_0$  of the strip line structure is:

$$Z_0 = \frac{138}{\sqrt{\epsilon}} \log \left( \frac{8h}{\pi d} \right)$$

The impedance  $Z_0$  of the microstrip line structure is:

$$Z_0 = \frac{138}{\sqrt{\epsilon}} \log \left( \frac{4h}{d} \right)$$

The printed wiring boards are formed in a multi-layered structure having outer conductor layers and an innermost conductor layer with dielectric layers therebetween. The ground conductor and the power supply conductor are usually located on the innermost conductor layer and thus constitutes a microstrip line structure in which the ground plane is arranged only on one side of the signal conductors.

There are proposals for electrical connectors having an impedance characteristic matching the impedance of the printed wiring boards to which the electrical connector is attached. For example, Japanese Examined Utility Model (Kokoku) 49-6543 discloses an electrical connector for printed wiring boards having a microstrip structure. This electrical connector is shown in Figs. 8A to 8C of the attached drawings, which comprises a plug connector member 50 and a jack connector member 52 matable with the plug connector

member 50. Fig. 8B is a cross-sectional view through the jack connector member 52 and Fig. 8C is a cross-sectional view through the plug connector member 50. The plug connector member 50 comprises a plug housing 54 of insulating material with three rows of holes in which a first row of male signal terminals 56, a second row of male signal terminals 58 and a generally planar and elongated male conductor 60 are fitted, respectively. The elongated male conductor 60 is arranged between the male signal terminals 56 and 58 so that a microstrip line structure is formed. The jack connector member 52 comprises a jack housing 62 of insulating material with three rows of holes 64, 66 and 68. A generally planar and elongated female conductor 70 is inserted in the central holes 68 to receive the elongated male conductor 60 for mating engagement therewith. Upper and lower female terminals 72 and 74 are inserted in the upper and lower holes 64 and 66, respectively, for mating engagement with the male signal terminals 56 and 58. The elongated female conductor 70 also forms a microstrip line structure with the female signal terminals 72 and 74. A shield case 76 is attached over the jack housing 62. This shield case 76 shields external electromagnetic waves and is not designed to control the impedance as a strip line structure.

In this connector, the male conductor 60 has a longer length than that of the male signal terminals 56 and 58 so that the male conductor 60 first engages the central holes 68 of the jack housing 62 to function as a guide when the plug connector member 50 is mated with the jack connector member 52. Also, the male conductor 60 has a central slit 78 that cooperates with a guide wall 78 of the jack housing 62 at the discontinuity of the central hole 68 to function as a guide when the plug connector member 50 is mated with the jack connector member 52.

United States Patent No. 4,762,500 also discloses an impedance matched electrical connector with a microstrip structure. This connector also includes a planar and elongated ground conductor and two rows of signal terminals on either side of the ground conductor to form a microstrip structure.

Recently, multi-layered printed wiring boards have been developed and the number of conductive layers of printed wiring boards is increasing. Thus the ground conductor and the power supply conductor are not necessarily located on the innermost conductor layer and are distributed on several layers so that the signal conductors are arranged between the ground conductor and the power supply conductor or between the ground conductors. In this case, a strip line structure is constituted in which the ground planes are arranged on either side of the signal conductors, since the constant-voltage power supply is deemed to be an equivalent of the ground regarding high frequency signal processing.

It is possible in principle to design an electrical connector having a microstrip line structure of a particular impedance matched to an impedance of a desired multi-layered printed wiring board. To this end, it is necessary to select the distance  $d$  between the center of the signal conductor and the ground plane in relation to the diameter of the signal conductor. In fact, however, when the density of the signal conductors becomes large, the diameter of the signal conductor becomes small and the pitch between the adjacent signal conductors becomes small. There is a problem in the electrical connector having a microstrip line structure of a particular impedance selected under these conditions that the impedance is relatively unstable and the occurrence of crosstalk is high.

The object of the present invention is to provide an impedance matched electrical connector in which an impedance is relatively stable and the occurrence of crosstalk is low.

According to the present invention, there is provided an impedance matched electrical connector comprising a plug connector member and a jack connector member matable with the plug connector member for an electric connection between printed wiring boards. The plug connector member comprises a plug housing of insulating material; the plug housing having an axis, an outer peripheral surface about the axis, at least one elongated hole arranged in a first plane parallel to the axis, a first row of small holes arranged in a second plane parallel to the first plane, and a second row of small holes arranged in a third plane parallel to the first plane on the side of at least one elongated hole remote from the first row of small holes; the outer peripheral surface including first and second opposite planar outer surface portions arranged parallel to the first plane in an overlapping relationship with at least one elongated hole and the first and second rows of small holes; at least one generally planar and elongated male conductor fitted in at least one elongated hole; a first row of male signal terminals fitted in said first row of small holes, respectively; a second row of male signal terminals fitted in said second row of small holes, respectively, and a conductive ground shell attached to the outer peripheral surface of the plug housing; the ground shell having a first planar shell portion covering the first planar outer surface portion such that a distance between the first planar shell portion and the first row of male signal terminals substantially equals a distance between the first row of male signal terminals and the elongated male conductor, and a second planar shell portion covering the second planar outer surface portion such that a distance between the second planar shell portion and the second row of male signal terminals substantially equals a distance between the second row of male signal terminals and the elongated male conductor, whereby an impedance of the first

and second rows of male signal terminals is controlled by at least one elongated male conductor and the ground shell. The jack connector member comprises a jack housing of insulating material, at least one female conductor for mating engagement with the elongated male conductor, a first row of female signal terminals for mating engagement with the first row of male signal terminals, and a second row of female signal terminals for mating engagement with the second row of male signal terminals.

With this arrangement, a strip line structure is constituted by the conductive ground shell and at least one female conductor between which the first row of male signal terminals and the second row of male signal terminals are respectively arranged via an insulating material of the plug housing. Therefore, an electrical connector having a relatively stable impedance and low occurrence of crosstalk is realized.

Preferably, at least one elongated male conductor comprises at least one male ground conductor and at least one male power supply conductor arranged in the first plane in a row, and at least one female conductor comprises correspondingly at least one female ground conductor and at least one female power supply conductor arranged in a plane in a row.

Preferably, the ground shell is connected to at least one elongated male conductor for electrical connection therebetween, and preferably for mechanical connection of the ground shell to the plug housing.

Preferably, the ground shell is formed in a continuously closed shape encircling the outer peripheral surface of the plug housing.

The plug housing preferably has a first end directed to a printed wiring board, a second end directed to the jack connector member, and an outer peripheral shoulder adjacent to the first end; the ground shell being arranged on the outer peripheral surface of the plug housing in an abutment relationship with the outer peripheral shoulder. The ground shell has a length such that the ground shell abuts one end thereof against the outer peripheral shoulder of the plug housing and extends beyond the second end of the plug housing to the jack housing. The jack housing preferably has an outer peripheral surface, a first end directed to the plug housing, a second end directed to another printed wiring board, and an outer peripheral shoulder adjacent to the second end of the jack housing; the ground shell extending beyond the second end of the plug housing to the jack housing with the first end of the jack housing abutting the second end of the plug housing.

In this case, the ground shell covers at least partly the outer peripheral surface of the jack housing so that a portion of the ground shell overlaps at least one female conductor. The ground shell extends between the outer peripheral shoulder of the plug housing and the outer peripheral shoulder of the jack housing. At least one elongated conductor of the plug connector member extends beyond the second end of the plug housing.

Preferably, the ground shell has a guide means and the jack housing has an associated guide means for assisting a mating engagement of at least one male conductor with at least one female conductor.

The present invention will become more apparent from the following description of the preferred embodiments, with reference to the accompanying drawings, in which:

Fig. 1 is an exploded perspective view of an electrical connector according to the first embodiment of the present invention;

Fig. 2 is a partially enlarged cutaway view of the plug connector member of Fig. 1;

Fig. 3 is a partially enlarged cutaway view of the jack connector member of Fig. 1;

Fig. 4 is a cross-sectional view of the electrical connector of Fig. 1, with the plug connector member and the jack connector member coupled together and shown in a position inverted from Fig. 1;

Fig. 5 is a cross-sectional view of the connector of Fig. 4 through the plug connector member;

Fig. 6 is a view of a jack connector member according to the second embodiment of the present invention;

Fig. 7 is a view of a plug connector member according to the third embodiment of the present invention; and

Figs. 8A to 8C are views of a prior art connector.

Figures 1 and 4 show an electrical connector 10 according to the present invention comprising a plug connector member 30 and a jack connector member 35 matable with the plug connector member 30 for an electric connection between printed wiring boards (not shown). Fig. 2 is a partially enlarged cutaway view of the plug connector member 30 and Fig. 3 is a partially enlarged cutaway view of the jack connector member 35.

As shown in Figs. 1, 2 and 4, the plug connector member 30 comprises a plug housing 31 of insulating material having an axis shown by the arrow in Fig. 1 along which the plug connector member 30 is mated with the jack connector member 35. The plug housing 31 has an outer peripheral surface 31a in a generally rectangular cross-sectional shape and an outer peripheral shoulder 31b adjacent to one end of the plug housing 31. The outer peripheral surface 31a includes first and second opposite planar outer surface

portions 31c and 31d extending along the long sides of the rectangular cross-sectional shape. The plug housing 31 also has a plurality of elongated holes 31e arranged in a first plane parallel to the axis and to the outer surface portions 31c and 31d, a first row of small holes 31f arranged in a second plane parallel to the first plane, and a second row of small holes 31g arranged in a third plane parallel to the first plane on the side of the elongated holes 31e remote from the first row of small holes 31g. The first and second opposite planar outer surface portions 31c and 31d, the elongated holes 31e, and the first and second rows of small holes 31f and 31g all extend perpendicular to the sheet of Fig. 4, and thus are parallel to each other in an overlapping relationship.

Planar and elongated male conductors 32 are fitted in the elongated holes 31e, respectively. The elongated male conductors 32 comprise at least one male ground conductor and at least one male power supply conductor arranged in the first plane in a row. As shown in Figs. 1 and 2, each of the elongated male conductors 32 has a sharpened end or contact 32a for connection to a corresponding female conductor and branched ends or contacts 32b for connection to a printed wiring board (not shown). The branched lead ends 32b extend from the outer peripheral shoulder 31b of the plug housing 31.

A first row of male signal terminals 33 are fitted in the first row of small holes 31f, respectively, and a second row of male signal terminals 33 are fitted in the second row of small holes 31g, respectively. Each of the male signal terminals 33 has a sharpened end or contact 33a for connection to a corresponding female signal terminal and other end or contact 33b for connection to a printed wiring board. The ends 33b of the male signal terminals 33 extend from the outer peripheral shoulder 31b of the plug housing 31 and the projecting end portions are bent in a staggered array. The male conductors 32 are made from a rigid flat plate of a good electric conductivity and the male signal terminals 33 are made from small rods of good electric conductivity.

A conductive ground shell 34 of good electric conductivity is attached to the outer peripheral surface 31a of the plug housing 31. The ground shell 34 is formed in a continuously closed shape encircling the outer peripheral surface 31a of the plug housing 31 and has a generally rectangular cross-sectional shape to fit over the plug housing 31. The ground shell 34 thus has a first planar shell portion 34a covering the first planar outer surface portion 31c of the plug housing 31 and a second planar shell portion 34b covering the second planar outer surface portion 31d of the plug housing 31. As shown in Fig. 5, the ground shell 34 is intended to provide a strip line structure for the signal terminals 33. To this end, the first planar shell portion 34a is arranged such that a distance between the first planar shell portion 34a and the first row of male signal terminals 33 substantially equals a distance between the first row of male signal terminals 33 and the elongated male conductors 32, and the second planar shell portion 34b is arranged such that a distance between the second planar shell portion 34b and the second row of male signal terminals 33 substantially equals a distance between the second row of male signal terminals 33 and the elongated male conductor 32.

The ground shell 34 is arranged on the outer peripheral surface 31a of the plug housing 31 in an abutment relationship with the outer peripheral shoulder 31b and has a length such that the ground shell 34 abuts one end thereof against the outer peripheral shoulder 31b of the plug housing 31 and extends beyond the end 31h of the plug housing 31.

The ground shell 34 has a tongue 34c at a small side of the ground shell 34; the tongue 34c being bent inwardly so that the tongue 34c is connected to the elongated male conductor 32 through a hole of the plug housing 31. The tongue 34c engages with the wall of the plug housing 31 and also serves to mechanically connect the ground shell 34 to the plug housing 31.

The ground shell 34 also has a pair of outwardly bulging arcuate guide walls 34d at opposite corners of the ground shell 34 along one side of the rectangular shape for assisting a mating engagement of the male conductors 32 with corresponding female conductors in the jack connector member 35.

As shown in Figs. 1, 3 and 4, the jack connector member 35 comprises a jack housing 36 of insulating material, elongated female conductors 37 for mating engagement with the elongated male conductor 32, a first row of female signal terminals 38 for mating engagement with the first row of male signal terminals 33, and a second row of female signal terminals 38 for mating engagement with the second row of male signal terminals 33.

The jack housing 36 has an outer peripheral surface 36a in a generally rectangular cross-sectional shape in conformity with the outer peripheral surface 31a of the plug housing 31, so that the plug housing 31 abuts the jack housing 36 in an end to end relationship when coupled together, as shown in Fig. 4. The jack housing 36 has an outer peripheral shoulder 36b adjacent to one end of the plug housing 31 that is remote from the plug housing 31 when coupled together. The outer peripheral surface 36a includes first and second opposite planar outer surface portions 36c and 36d, a plurality of elongated holes 36e for inserting the elongated female conductors 37, and first and second rows of small holes 36f and 36g for inserting the

female signal terminals 38.

Each of the elongated female conductors 37 has branched female ends or contacts 32a for receiving the sharpened end 32a of the male conductors 32 and branched lead ends or contact 32b for connection to another printed wiring board (not shown). Each of the female signal terminals 38 has a female end or contact 38a for receiving the sharpened end 33a of the male signal terminal 33 and other end or contact 37b for connection to another printed wiring board. The ends 38b of the female signal terminals 38 are bent in a staggered array. The female conductors 37 are made from a combination of elastic flat plates of good electric conductivity and the female signal terminals 38 are made from small rods of good electric conductivity.

The jack housing 36 has a pair of ridges 36c at opposite corners of the jack housing 36. The ridges 36c mate with the guide walls 34d of the ground shell 34 for assisting a mating engagement of the male conductors 32 with the corresponding female conductors 37 in the jack connector member 35 and for preventing an inaccurate insertion.

The ground shell 34 extends beyond the end of the plug housing 31 to the jack housing 36 with one end of the jack housing 36 abutting the second end of the plug housing 31, as shown in Fig. 4. Preferably, the ground shell 34 covers at least partly the outer peripheral surface 36a of the jack housing 36 so that a portion of the ground shell 34 overlaps the female conductors 37. Preferably, the ground shell 34 extends between the outer peripheral shoulder 31b of the plug housing 31 and the outer peripheral shoulder 36b of the jack housing 36. Accordingly, the ground shell 34 also acts with the elongated female conductors 37 in the jack housing 36 to constitute a strip line structure for the female signal terminals 38.

Figure 6 is a view of a jack connector member 35 according to the second embodiment of the present invention. This jack connector member 35 has a similar arrangement to that of the jack connector member 35 of Fig. 3, except that the jack connector member 35 of Fig. 6 is taller than that of the latter and the ground shell 34 cannot fully cover the elongated female conductors 37 in the jack housing 36. In this case, an additional conductive ground shell 34 is attached to the jack housing 36. Preferably, the first ground shell 34 is arranged to extend the plug housing 31 and to abut the outer peripheral shoulder 36b of the jack housing 36, and the second ground shell is arranged on the outer peripheral shoulder 36b of the jack housing 36, so that the first and the second ground shells 34 and 39 are substantially continuous. The second ground shell 39 has a tongue 39a at a small side of the ground shell 39 for an electrical connection to the elongated female conductor 37.

The following table is a result of a test of impedance and crosstalk on three electrical connectors A to C. The connector A is the connector 10 of the first embodiment, and the connectors B and C are connectors having identical shapes to the connector 10, and the connector B has the ground shell 34 attached to the plug housing 31 but is not connected to the ground. The connector C does not have the ground shell 34 attached to the plug housing 31 and has a microstrip line structure.

load	50 $\Omega$		
connector	C	B	A
impedance ( $\Omega$ )	58.3	49.3	49.2
crosstalk (mV)			
(near-end)	350	235	230
(far-end)	80	10	5

The near-end crosstalk is a value measured at the pulse input side (the jack side) and the far-end crosstalk is a value measured at the plug side. As will be apparent that the connector A can realize a small amount of crosstalk, compared to the other connectors. The connector B showed a similar impedance to that of the connector A. The reason is not apparent but may be derived from the fact that a few number of the signal terminals are activated in the test and the ground shell 34 is large in size so that the ground shell 34 is at an stable potential during the test as if it is connected to the ground. It will be apparent that the

ground shell 34 should be preferably connected to the ground in the actual use. Also, it is preferable that the rows of signal terminals 33 and 38 are located at the center between the elongated conductors 32 and 37 and the planar shell portions 34a and 34b of the ground shell 34 for most effectively reducing the amount of crosstalk.

The electrical connector 10 has 100 signal terminals 33 arranged in the plug housing 31 having the size of, for example, 64 mm in length along the long side thereof and 4 mm in length along the short side thereof. The height of the electrical connector 10 is approximately 20 mm. The electrical connector 10 is adapted to high speed signal processing in the level of, for example, approximately 1 GHz. Therefore, it is preferable to select the insulating material of the plug housing 31 and the jack housing 36 having a low dielectric constant adapted for such a high frequency level to effectively reduce the amount of the crosstalk. It has been found that a liquid crystal polymer is adapted for the insulating material of the plug housing 31 and the jack housing 36. In addition, the liquid crystal polymer has a sufficient strength to allow the plug housing 31 and the jack housing 36 to have a thin walled structure as described above and a temperature resistive property to endure heat during a soldering process. The liquid crystal polymer has a good flowability in a molding process.

Figure 7 is a view of a plug connector member 30 according to the third embodiment of the present invention. The plug connector member 30 comprises a plug housing 31, the elongated male conductors 32, the ground shell 34, and other elements such as signal terminals, similar to the plug connector member 30 of fig. 2. The tongue 34c of Fig. 2 is replaced by tongue 41 in Fig. 7. The tongue 41 extends from one end of the ground shell 34 and is bent along the end surface of the plug housing 31 from which the branched ends 32b of the elongated male conductor 32 project. The tongue 41 has a hole 40 through which one of the branched ends 32b of the elongated male conductor 32 is passed for establishing an electric connection between the ground shell 34 and the elongated male conductor 32 and a mechanical connection of the ground shell 34 to the plug housing 31. If the outer peripheral shoulder 31b is provided adjacent to the end of the plug housing 31 it is possible to provide a slit at the outer peripheral shoulder 31b for passage of the tongue 41. Also, the tongue 39a of Fig. 6 can be replaced by a tongue similar to 41 in Fig. 7.

As explained in detail, it is possible to obtain an electrical connector having a desired impedance characteristic in a strip line structure for matching an impedance characteristic of printed wiring boards, and to realize an electrical connector having a stable impedance characteristic less affected by external noise and the amount of crosstalk is relatively low based on the strip line structure.

## Claims

1. An impedance matched electrical connector comprising a plug connector member (30) and a jack connector member (35) matable with the plug connector member (30) for an electric connection between printed wiring boards, said plug connector member (30) comprising:

a plug housing (31) of insulating material having an axis, an outer peripheral surface (31a) about the axis, at least one elongate hole (31e) arranged in a first plane parallel to the axis, a first row of small holes (31f) arranged in a second plane on one side of and parallel to the first plane, and a second row of small holes (31g) arranged in a third plane on the other side and parallel to the first plane; the outer peripheral surface (31a) including first and second opposite planar outer surface portions (31c, 31d) arranged parallel to the first plane in an overlapping relationship with the said elongate hole (31e) and the first and second rows of small holes (31f, 31g);

at least one generally planar and elongate male conductor (32) fitted in at least one elongate hole (31e);

a first row of male signal terminals (33) fitted in said first row of small holes (31f), respectively;

a second row of male signal terminals (33) fitted in said second row of small holes (31g) respectively; and

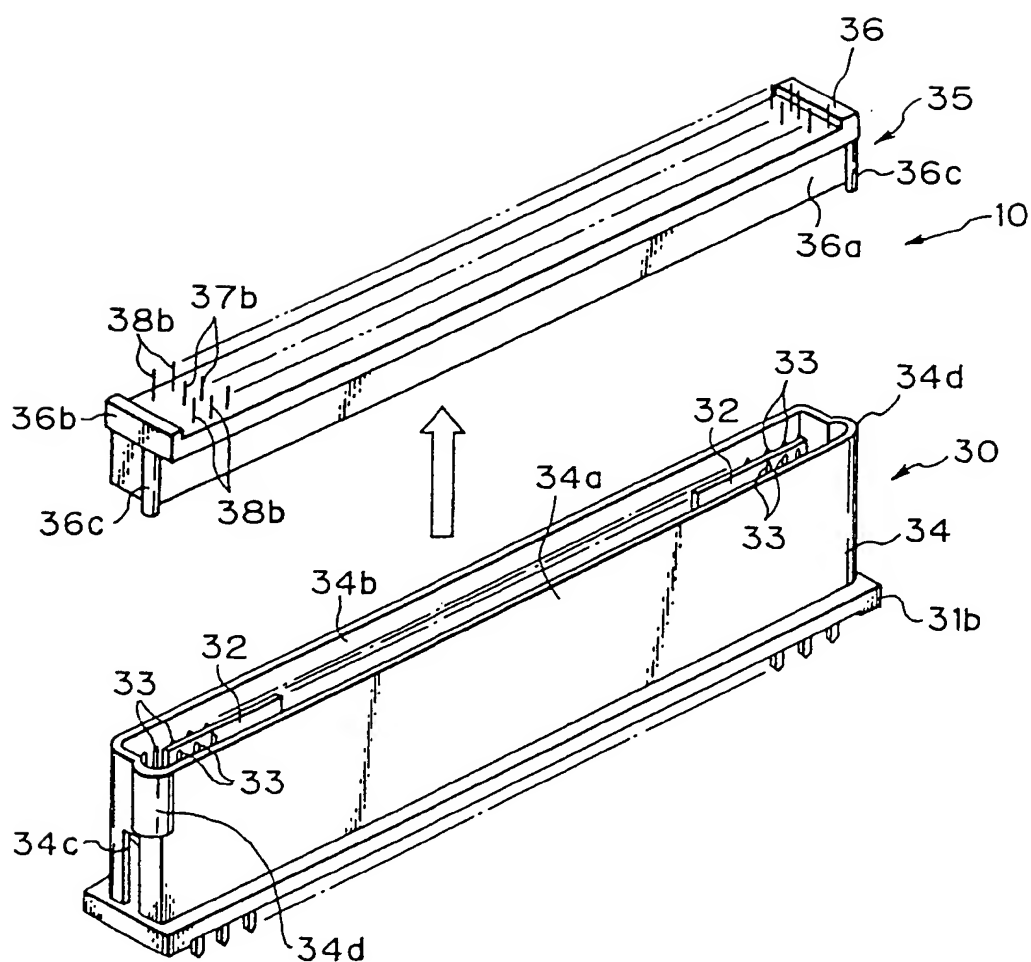
a conductive ground shell (34) attached to the outer peripheral surface (31a) of the plug housing (31), the ground shell (34) having a first planar shell portion (34a) covering the first planar outer surface portion (31c) such that the distance between the first planar shell portion (34a) and the first row of male signal terminals (33) substantially equals the distance between the first row of male signal terminals (33) and the elongate male conductor (32), and a second planar shell portion (34b) covering the second planar outer surface portion (31d) such that the distance between the second planar shell portion (34b) and the second row of male signal terminals (33) substantially equals the distance between the second row of male signal terminals (33) and the elongate male conductor (32), whereby the impedance of the first and second rows of male signal terminals (33) is determined by the elongate male conductor (32) and the ground shell (34);

and the jack connector member (35) comprising a jack housing (36) of insulating material, at least one female conductor (37) for mating engagement with the elongate male conductor (32), a first row of female signal terminals (38) for mating engagement with the first row of male signal terminals (33), and a second row of female signal terminals (38) for mating engagement with the second row of male signal terminals (33).

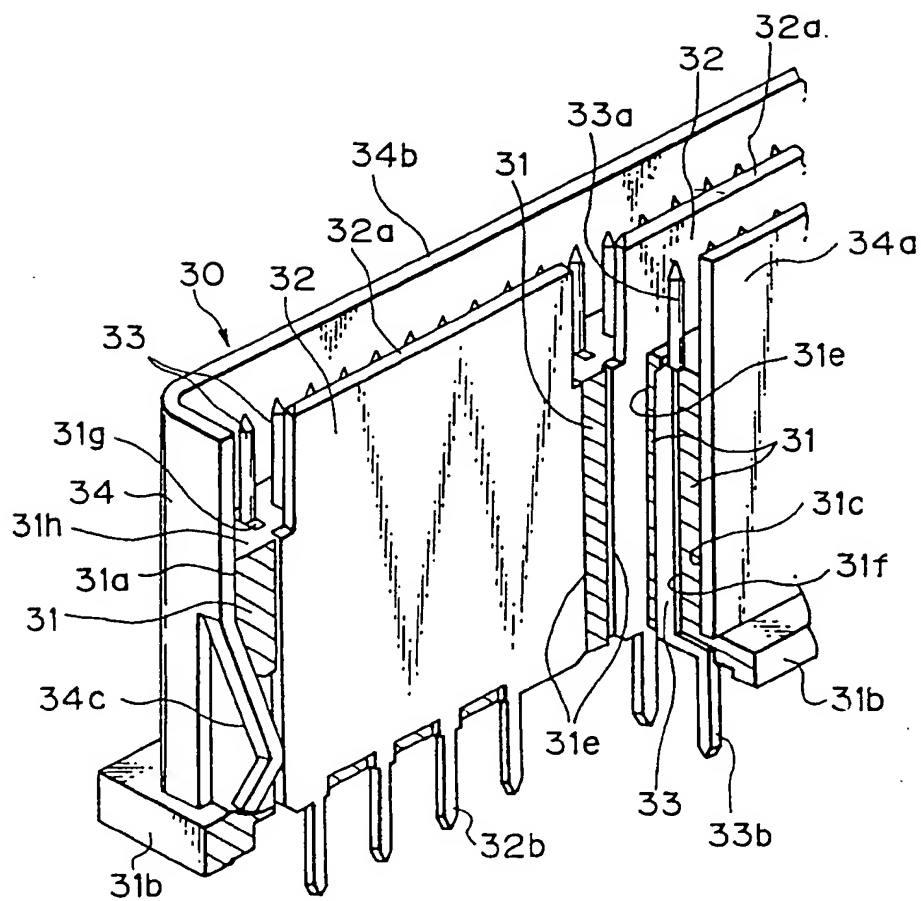
2. A connector according to any preceding claim, wherein at least one female conductor (37) of the jack connector member (35) is generally planar and elongate.
3. A connector according to any preceding claim, wherein at least one elongate male conductor (32) comprises at least one male ground conductor and at least one male power supply conductor arranged in the first plane in a row, and at least one female conductor (35) comprises correspondingly at least one female ground conductor and at least one female power supply conductor arranged in a plane in a row.
4. A connector according to any preceding claim, wherein the ground shell (34) is connected to at least one elongate male conductor (32) for electrical connection therebetween.
5. A connector according to any preceding claim, wherein the ground shell (34) is connected to at least one elongate male conductor (32) for electrical connection therebetween and for mechanical connection of the ground shell (34) to the plug housing (31).
6. A connector according to any preceding claim, wherein the ground shell (34) is formed in a continuously closed shape encircling the outer peripheral surface (31a) of the plug housing (31).
7. A connector according to any preceding claim, wherein the plug housing (31) has a first end directed to a printed wiring board, a second end (31h) directed to the jack connector member (35), and an outer peripheral shoulder (31b) adjacent to the first end, the ground shell (34), being arranged on the outer peripheral surface (31a) of the plug housing (31) in an abutment relationship with the outer peripheral shoulder (31b).
8. A connector according to claim 7, wherein the ground shell (34) abuts at one end thereof the outer peripheral shoulder (31b) of the plug housing (31) and extends beyond the second end (31h) of the plug housing (31).
9. A connector according to claim 7 or 8, wherein the jack housing (36) has an outer peripheral surface (36a), a first end directed to the plug housing (31), a second end directed to another printed wiring board, and an outer peripheral shoulder (36b) adjacent to the second end of the jack housing (36); the ground shell (34) extending beyond the second end (31h) of the plug housing (31) to the jack housing (36) with the first end of the jack housing (36) abutting the second end (31h) of the plug housing (31).
10. A connector according to claim 9, wherein the ground shell (34) covers at least partly the outer peripheral surface (36a) of the jack housing (36) so that a portion of the ground shell (34) overlaps at least one female conductor (37).
11. A connector according to claim 9, wherein the ground shell (34) extends between the outer peripheral shoulder (31a) of the plug housing (31) and the outer peripheral shoulder (36b) of the jack housing (36).
12. A connector according to one of claims 7 to 11, wherein at least one elongate conductor (31e) of the plug connector member (30) extends beyond the second end (31h) of the plug housing (31).
13. A connector according to any preceding claim, wherein the ground shell (34) has a guide means and the jack housing (36) has an associated guide means for assisting a mating engagement of at least one male conductor with at least one female conductor.



*Fig. 1*



*Fig. 2*



*Fig. 3*

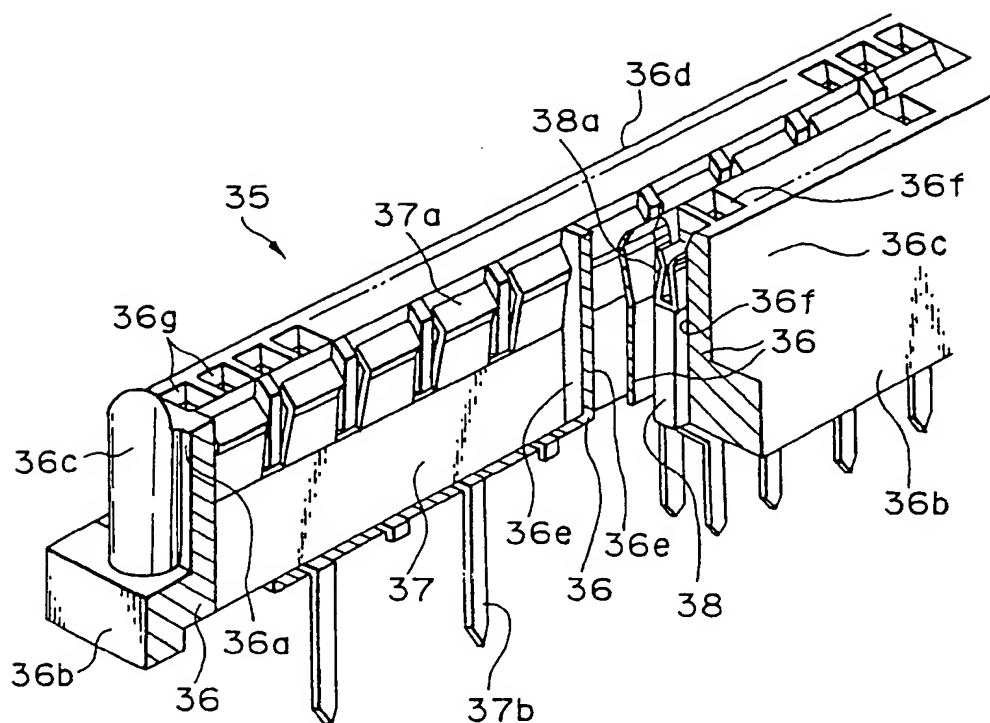


Fig. 4

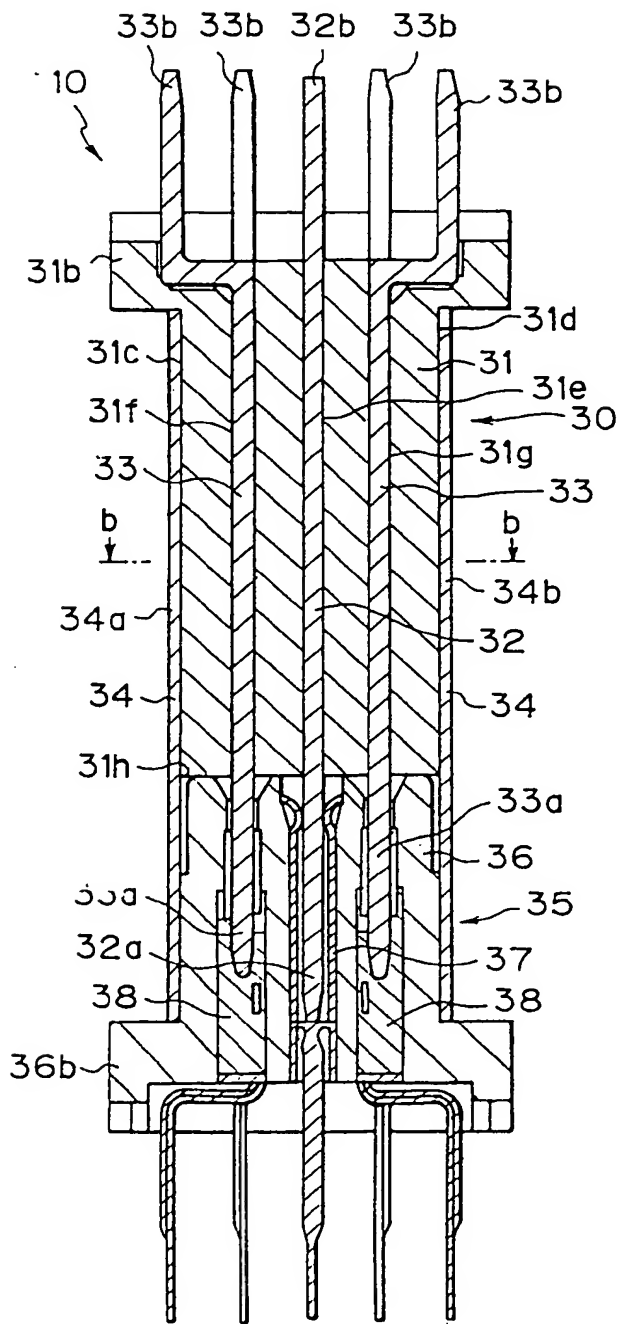


Fig. 5

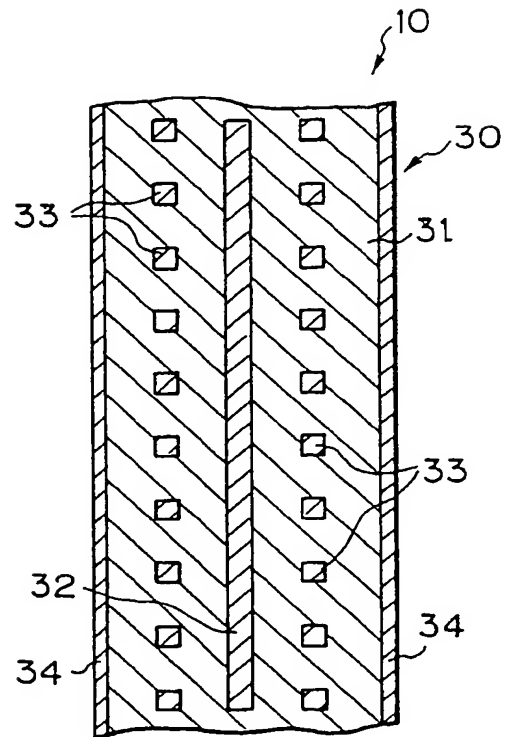
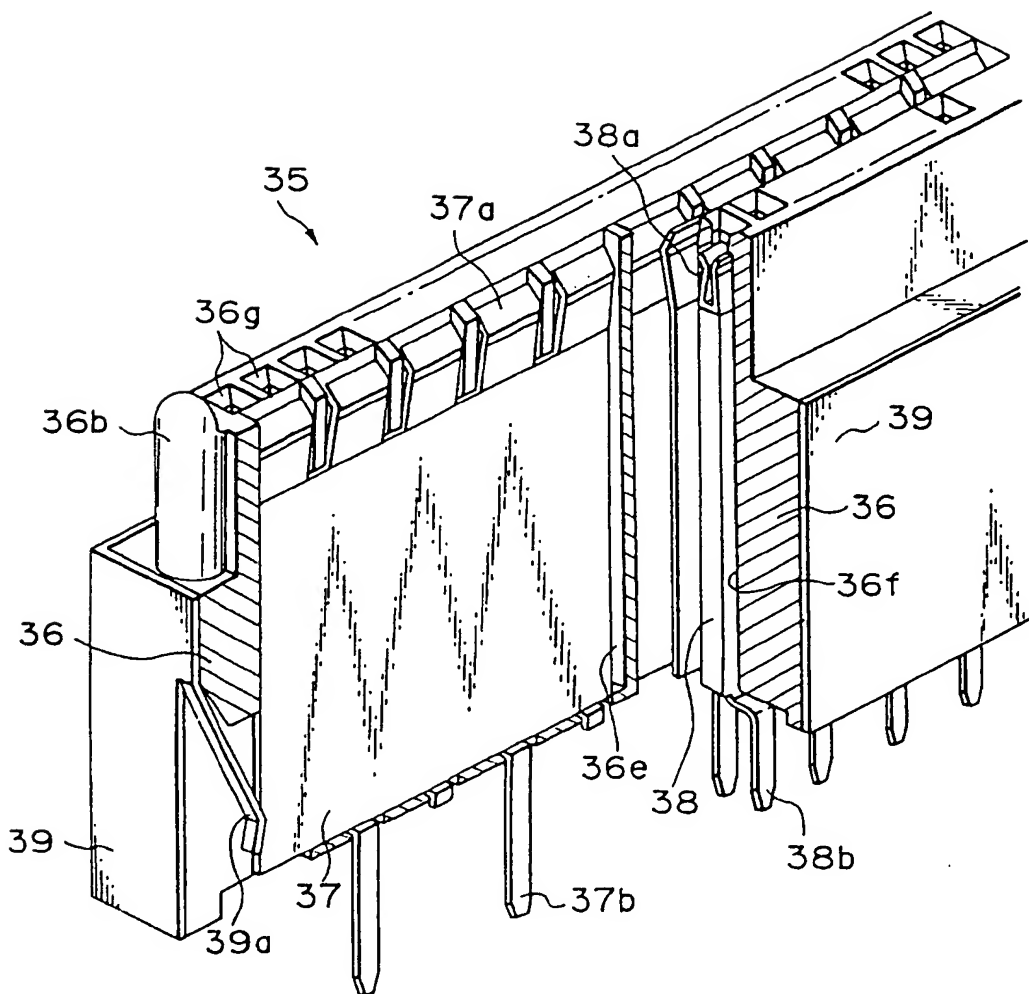


Fig. 6



*Fig. 7*

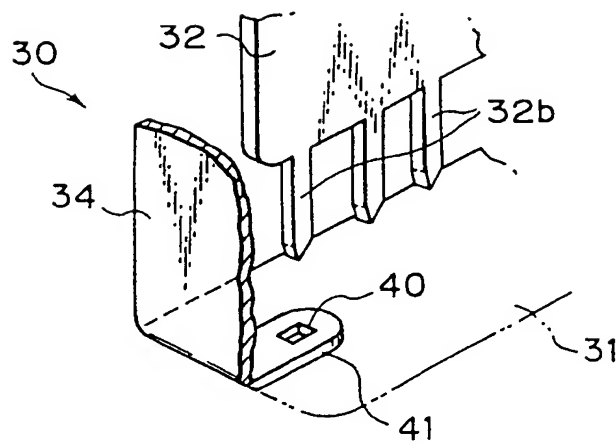


Fig. 8A

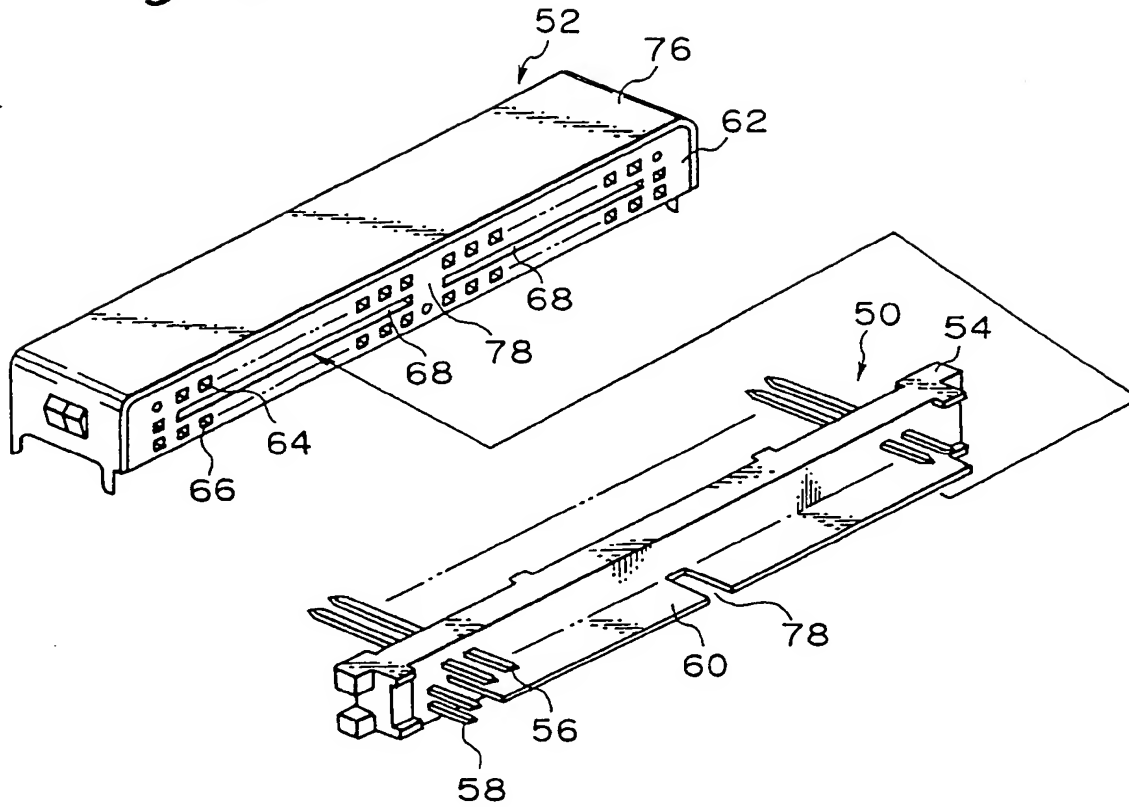


Fig. 8B

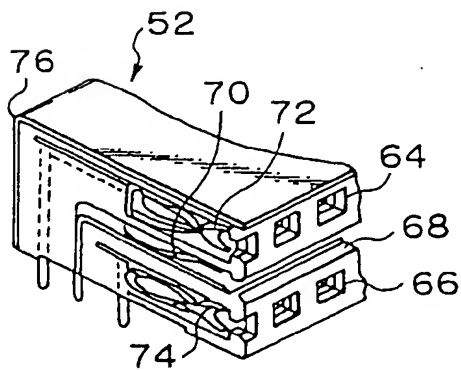
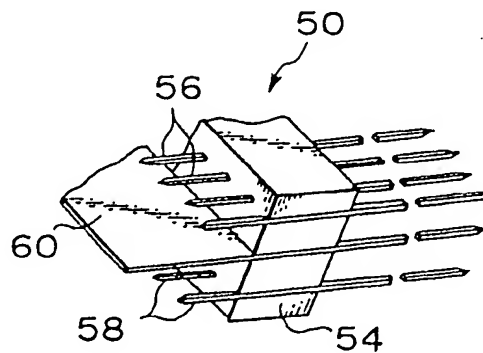


Fig. 8C





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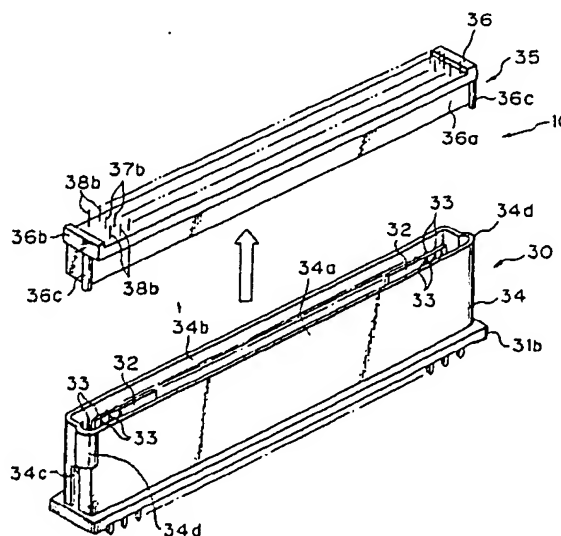
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(54) **Impedance-matched electrical connector.**

(57) An impedance-matched electrical connector comprising a plug connector member (30) and a matable jack connector member (35) for an electric connection between printed wiring boards. The plug connector member (30) comprises a plug housing (31) of insulating material in which planar and elongate male conductors (32), a first row of male signal terminals (33), and a second row of male signal terminals (33) are arranged in parallel planes. A conductive ground shell (34) is attached to the outer peripheral surface (31a) of the plug housing (31), so that the first and second rows of male signal terminals (33) are arranged between the elongate male conductors (32) and a planar portion of the ground shell, respectively, to thereby form a strip line structure by which an impedance of the connector is matched to an impedance of the printed wiring boards and the amount of crosstalk is relatively low.

*Fig. 1*







European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 92303995.2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	<u>WO - A - 88/04 484</u> (AMP) * Abstract; fig. 1,2; page 1, lines 19ff; page 3, lines 27ff; claims 1-3 *	1-13	H 01 R 9/09 H 01 R 23/00
Y	<u>US - A - 4 941 848</u> (PHILIPPSON et al.) * Abstract; claim 1; fig. *	1-13	
A	<u>EP - A - 0 410 769</u> (THOMAS & BETTS) * Abstract; column 4, lines 38ff *	1-13	
A	<u>US - A - 3 900 805</u> (STEVENS)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H 01 P 5/00 H 01 R 9/00 H 01 R 13/00 H 01 R 23/00
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 06-09-1993	Examiner BLASL
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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